MTP Medical Technology Program

U.S. Department of Energy

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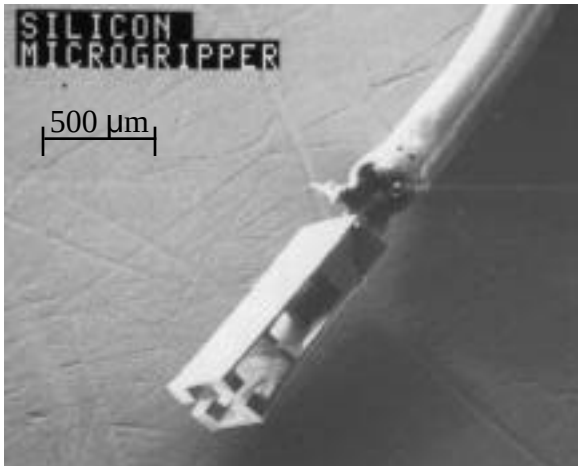
Silicon Microgripper

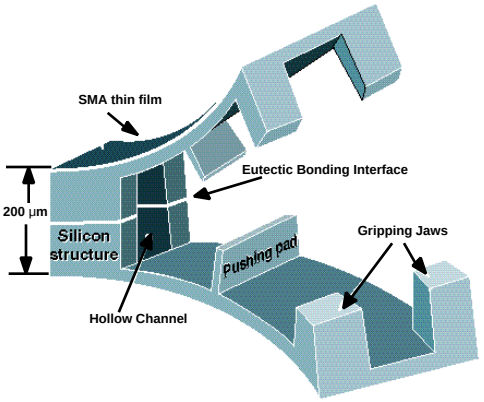
The Need for the Microgripper

Designers of tools for surgeons performing modern minimally-invasive surgery are challenged to create miniaturized systems to hold, grab and release materials, often at the end of a multi-meter length catheter deep within a patient's arterial system. Research engineers at the Lawrence Livermore National Laboratory have developed a silicon microgripper that is actuated by shape memory alloy (SMA) thin films. This microgripper device can be used for remote manipulation in small areas via access through small holes or catheters. This device can also be used in conjunction with other microtools to go through a singular trocar in laparoscopic procedures and reduce the amount of incisions required, and cut down on the exchange of tools. Our microgripper generates a large gripping force ([a] 13mN), has a relatively rigid structural body and is designed with small cross-sectional areas to facilitate entry through small holes.



An electron micrograph of the silicon microgripper developed at LLNL.

The microgripper is fabricated by alignment and selective eutectic bonding of two preprocessed silicon wafers. After bonding, the individual microgripper structures are formed by bulk silicon etching with double-sided alignment and precision depth-controlled sawing. The fabrication process allows the designer some flexibility in shaping the gripping jaws to match the object being gripped. Also, batch fabrication allows for highly automated processing and reduces manufacturing costs. Ni-Ti-Cu SMA films developed at LLNL are deposited to generate high actuation force (500MPa) with low applied temperature gradients (30° C- 70° C).

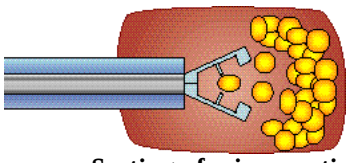


A schematic of the silicon microgripper.

The stress induced can open each side of the microgripper by up to 55 µm for a total gripping motion of 110 µm. Due to hysteresis, the SMA must reach 70° C initially. The gripper will remain open if the temperature is immediately (within milliseconds) lowered to 55° C. Further reduction in temperature closes the gripper. Preliminary tests indicate the gripper uses about 0.1 W in air and 0.2 W in water.

Applications

- **Biopsy**
- **Endovascular deposition of thrombogenic materials**
- **Release and retrieval of coils for aneurysm treatment:**



- **Sorting of micro particles**
- ***In vitro* manipulation of cells**

Continued Research

The Microtechnology Center at LLNL is developing a variety of microtools for use in biomedical applications, and is pursuing industrial partners for commercializing these devices.

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